Project Title: **Improved monitoring network for new invasive insect pests in Ohio**

Final report to the Ohio Vegetable & Small Fruit Research & Development Program, 1/29/2018

Principal Investigators: Celeste Welty, Jim Jasinski, Elizabeth Long

Part 1: Spotted wing drosophila (SWD)

Overview: Since the first detection of Spotted Wing Drosophila (SWD) in September, 2011, the OSU Extension IPM program and the Dept. of Entomology have joined forces to create a statewide monitoring network for this invasive pest. This network has mostly been run by Extension Educators who monitor for this pest on a weekly basis at grower farms in their county, on crops such as raspberry, strawberry, blueberry, grapes, blackberry, and peaches, and then report that information on a website (http://u.osu.edu/pestmanagement/) for others to view. The key to this network remaining successful is the short time between trap check and identification of any SWD flies in the sample, so that growers can swiftly begin their management plan upon the first detection of this pest.

Monitoring Network: The network in 2017 was slightly smaller than 2016, with 13 Extension Educators, 3 state specialists, and 1 research station manager collaborating over 19 counties. There were a total of 40 sites (fruit plantings), with 1-4 traps deployed per site. As in 2016, the commercially available Scentry trap was used, which is similar to a standard 24 oz. peanut butter jar with a screw top lid (**Figure 1**). The commercial Scentry lure was used as the main bait, which lasts for about 30 days before needing to be replaced. The trap hangs from an "S" shaped metal hook that passes through the lid, and attaches the trap to a plant stem or trellis. The drowning solution was 25% apple cider vinegar (ACV) to preserve specimens between weekly collections, plus a drop of detergent. Most of the traps in the network used the Scentry trap and lure combination throughout the season. Some sites used this combination until the first confirmed detection of SWD, and then switched over to 100% ACV as both the bait and drowning solution. This was done to reduce the number of SWD and non-target insects caught at those sites, which dramatically reduced the time spent identifying these pests, once SWD presence had clearly been established at a site.

Figure 1. SWD Scentry trap used in 2016 and 2017.

Trap deployment and timing: For most of the SWD network, traps were set up in the field during the first week of June. Traps remained in the field at their original site for a time period that varied from several weeks to the entire season, while some traps were moved among different crops at the same farm during the season depending on the presence or absence of ripening fruit. Traps were removed from the field by the first week of October. The current distribution of this pest as recorded by the trapping network in 2017 is shown in **Figure 2**.

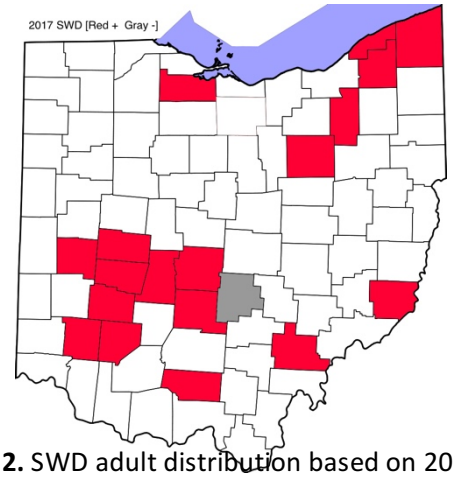

Figure 2. SWD adult distribution based on 2017 monitoring network; red counties are SWD positive, white or gray counties are SWD negative.

At a few sites, traps were placed in the field or near the edge of wooded areas much earlier, from January through May, in an effort to determine if SWD adults were active before our main network was set up. At those early-trapped sites, Franklin County captured SWD adults during the week of Jan. 1-7, April 2-8, and May 21-27. In Greene and Clinton

Counties, SWD adults were detected May 21-27. Although our small sample size of a few counties does not represent the entire trapping area, it does confirm what researchers in other states are finding, specifically that SWD adults are alive and active in non-crop areas, such as woods, early in the season and begin to slowly migrate from these areas to infest cultivated crops as the season progresses. **These early detections reinforce our recommended management process which continues to be 1.) monitor the crop early, 2.) be able to identify SWD in traps, and 3.) protect ripening fruit with insecticide or nets if SWD adults are detected.**

First catch: For the main network, the first SWD adult captures occurred during the week of June 4-10 at Champaign County on raspberries, Miami County on grapes, and Clinton County on raspberries. The following week, Clark County reported SWD on raspberries and Greene County reported SWD on blueberries, raspberries, and blackberries. These initial detections are about one week earlier in the season compared to what we saw in 2016. Full details of counties, cooperators, crops, bait types, and first detection of SWD can be found in Table 1.

Peak catch: Peak trap catches provide a snapshot of which week has the highest trap counts in a county among all sites. This is simply meant to show that most peak detections are from late July through September. Peak trap catches per trap per week can range from 41 to 1,020 adult SWD flies.

Table 1. First detection and peak detection of SWD adults, by week. Multiple dates per county indicate traps being placed in the field before the main network went active the first week of June.

County	Cooperator	First Catch Date	Peak Catch Date
Ashtabula	L. Ober, A. Kirk	Jun 18-24	Aug 27- Sep 2
Athens	E. Brown	Jun 18-24	Aug 6-12
Champaign	A. Douridas	Jun 4-10	Jul 23-29
Clark	J. Jasinski	Jun 11-17	Oct 1-7
Clinton	J. Jasinski	May 21-27, Jun 4-10	Jul 23-29
Fairfield	J. Iles	no detects	no detects
Franklin	C. Welty, K. Vik	Jan 1-7, Apr 2-8, May 21-27	Aug 27- Sep 2
Geauga	E. Draper	Jul 2-8	Sep 17-23
Greene	J. Jasinski	May 21-27, Jun 11-17	Sep 24-30
Lake	L. Ober	Jul 23-29	Aug 6-12
Madison	M. Griffith	Jul 2-8	Jul 23-29
Miami	A. Bennett	Jun 4-10	Jul 16-22
Monroe	M. Landefeld	Jun 25-Jul 1	Aug 6-12
Pickaway	M. Estadt	Jun 18-24	Aug 20-26
Pike	R. Slaughter	Jun 25-Jul 1	Jul 30-Aug 5
Sandusky	A. Gahler	Jul 2-8	Aug 13-19
Summit	J. Kowalski	Jul 2-8	Jul 2-8
Warren	J. Jasinski	Jun 25-Jul 1	Sep 10-16
Wayne	R. Lewandowski	May 21-27	Aug 13-19

Overlaying Insecticide Records with Adult and Larval Monitoring: Intensive trapping for adults was performed on farms in Clark, Clinton, Greene, Warren, and Franklin Counties. SWD populations were mapped with the insecticide sprays applied to these crops for all counties except Franklin and Clinton, to document the effects of certain insecticide programs on fly populations. In addition to adult

captures at these sites, fruit were collected periodically and put through the salt water test in order to establish if any SWD larvae were present, as an indirect measure spray efficacy.

Greene County site: This farm operation had three crops that were monitored for SWD populations; blueberries, raspberries, and blackberries. Due to a late May freeze, most of the blueberry crop was lost. No insecticides were applied to this crop and only two salt water tests were performed on 21 June and 5 July, on roughly 100 mature berries which revealed no larvae. The adult population rose slowly through the season, even though fruit set was very minimal, except when checked by weather events such as rain (**Figure 3**).

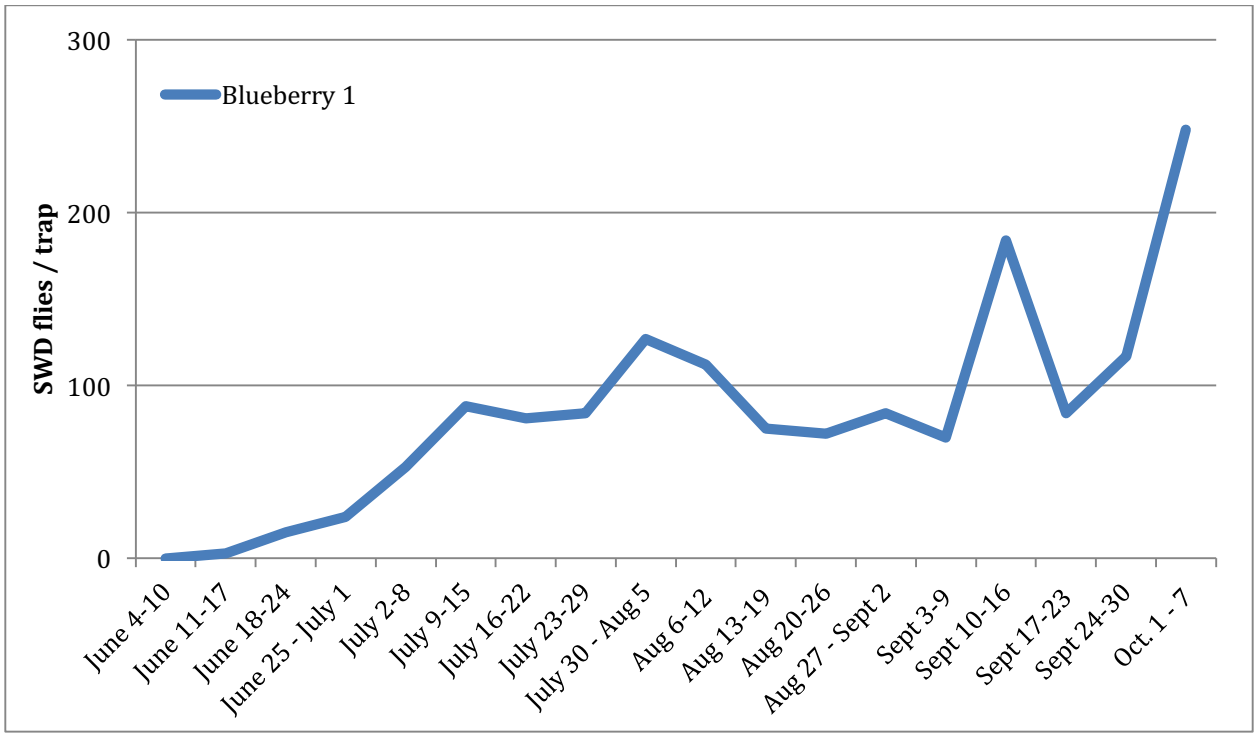

Figure 3. Adult SWD population trends in **Greene** County in **blueberry** using a single Scentry trap and lure. No insecticide sprays were applied to this crop in 2017.

The blackberry and raspberry crops at the Greene County site were relatively unharmed by the late freeze, and flowered and fruited normally. Each crop was monitored weekly using two Scentry traps spaced ca. 100 ft apart. The grower sprayed four different insecticides (four active ingredients) on the same 3-7 day schedule to protect both crops from SWD oviposition and subsequent larval damage. In both blackberry (**Figures 4**), and raspberry (**Figure 5**), insecticide application dates are indicated by colored arrows, which also differentiate the products used; red arrows indicate malathion, green arrows indicate Evergreen (pyrethrins + PBO), yellow arrows indicate Entrust (spinosad), and black arrows indicate Mustang Maxx (zeta-cypermethrin). In both blackberry and raspberry crops, applications of malathion, Evergreen, and Entrust were used early to mid season to suppress the population below 200 flies per trap. As fly populations continued to rise, two applications of Mustang Maxx plus Entrust and Evergreen, reduced the populations below 100 flies per trap. The last two Entrust applications in both crops held the fly trap numbers down through mid-September before ballooning to ca. 500 flies per trap

in the blackberries and 400 flies per trap in the raspberries during the last few weeks of no insecticide use. Applications made on 29 Jul, 5, 12, 19, and 26 Aug had sucrose sugar added to the mixture to enhance attraction of the SWD flies to the insecticide spray. Salt water tests of the blackberries 26 July – 6 September revealed between 10 - 259 larvae per 50 healthy berries (**Figure 4**), and in the raspberries, the larval counts were a bit lower at 0 - 82 larvae per 50 healthy berries (**Figure 5**).

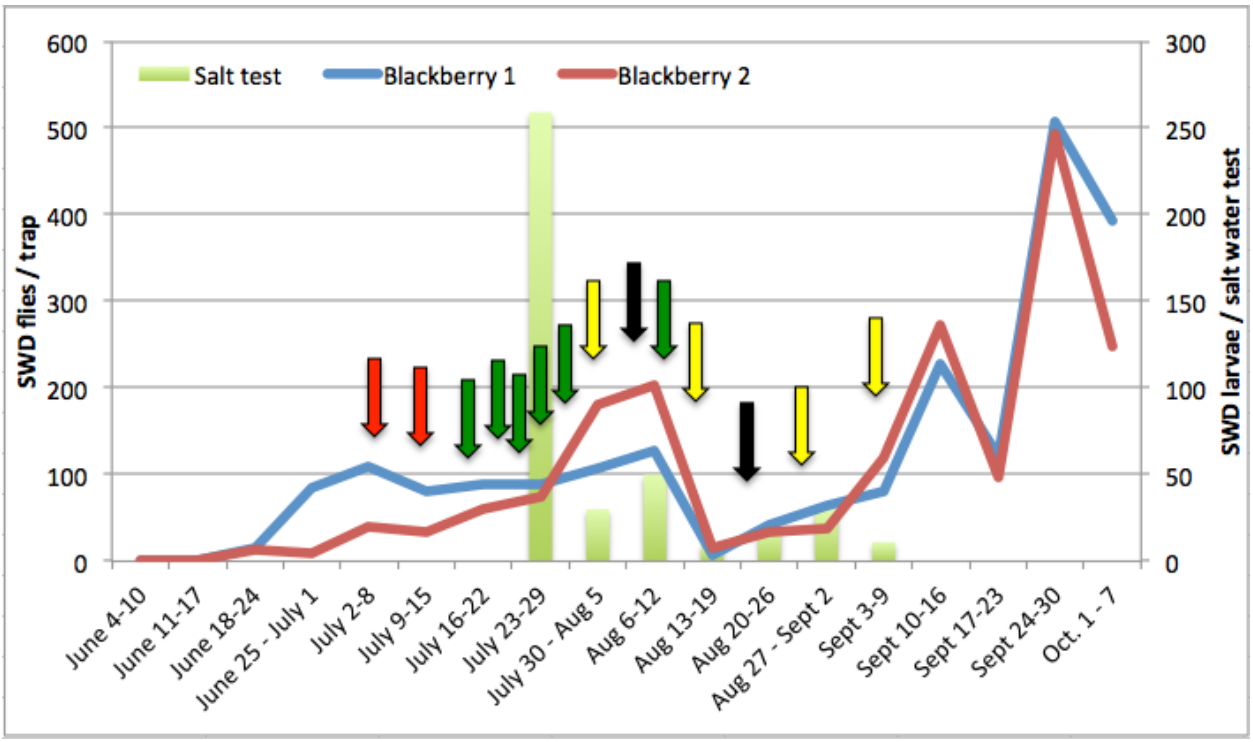

Figure 4. Adult SWD population trends in **Greene** County in **blackberry** using Scentry trap and lure. Larval populations in fruit were monitored through salt water tests (green bars). Red arrows indicate malathion, green arrows indicate Evergreen, yellow arrows indicate Entrust, and black arrows indicate Mustang Maxx. Applications made on 29 Jul, 5, 12, 19, and 26 Aug had sucrose sugar added to the mixture.

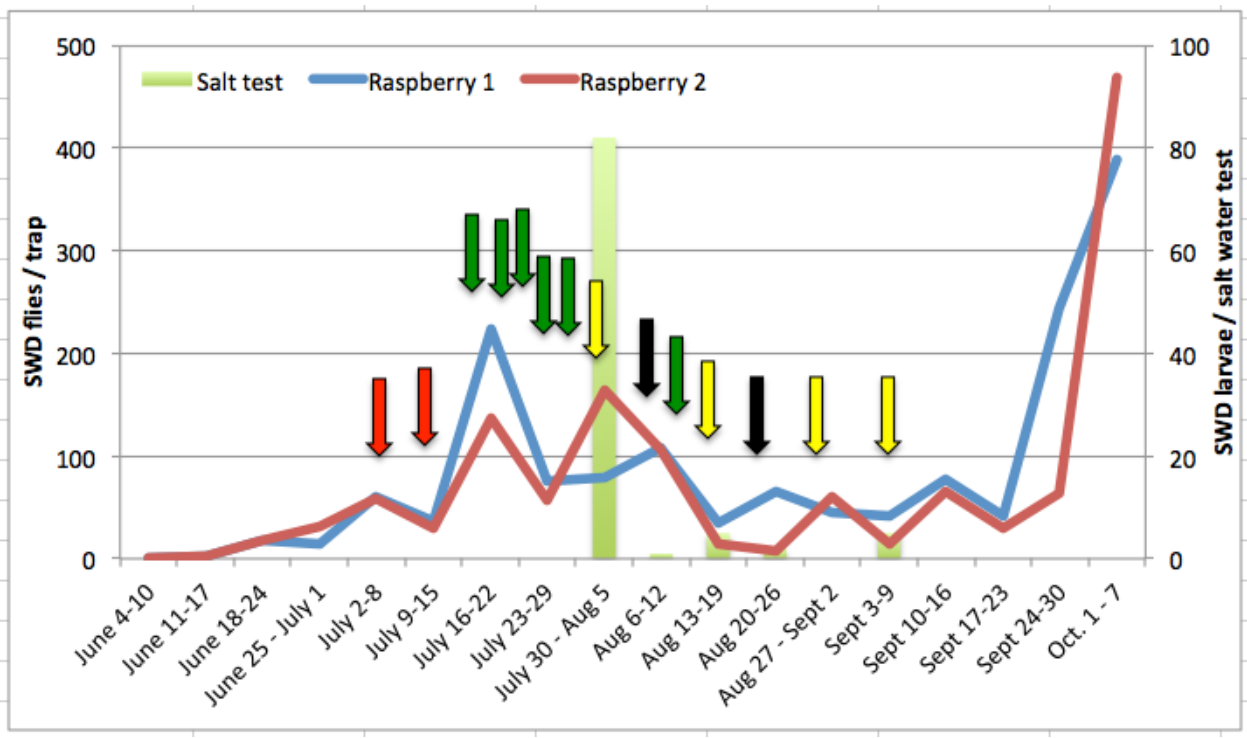

Figure 5. Adult SWD population trends in **Greene** County in **raspberry** using Scentry trap and lure. Larval populations in fruit were monitored through salt water tests (green bars). Red arrows indicate malathion, green arrows indicate Evergreen, yellow arrows indicate Entrust, and black arrows indicate Mustang Maxx. Applications made on 29 Jul, 5, 12, 19, and 26 Aug had sucrose sugar added to the mixture.

Clark County: A raspberry field was monitored weekly for SWD fly counts using Scentry traps and lures. The grower made three applications of Mustang Maxx from 24 June – 7 July, which kept the fly pressure below nine adults per trap (**Figure 6**). The crop was fully harvested by 12 July and no more insecticide applications were made. After harvest, a slow but steady rise of adults were captured in the Scentry traps through the end of the season despite low levels of available fruit. Two salt water tests were conducted on 21 June and 5 July revealed no larvae in the fruit. This site demonstrates how SWD fly monitoring combined with proper timing of highly effective insecticides can allow growers to maximize their marketable fruit in a U-pick operation with minimal risk from SWD crop damage. The only recommendation at this site not being followed is the alternation of chemical classes between applications to help avoid insecticide resistance.

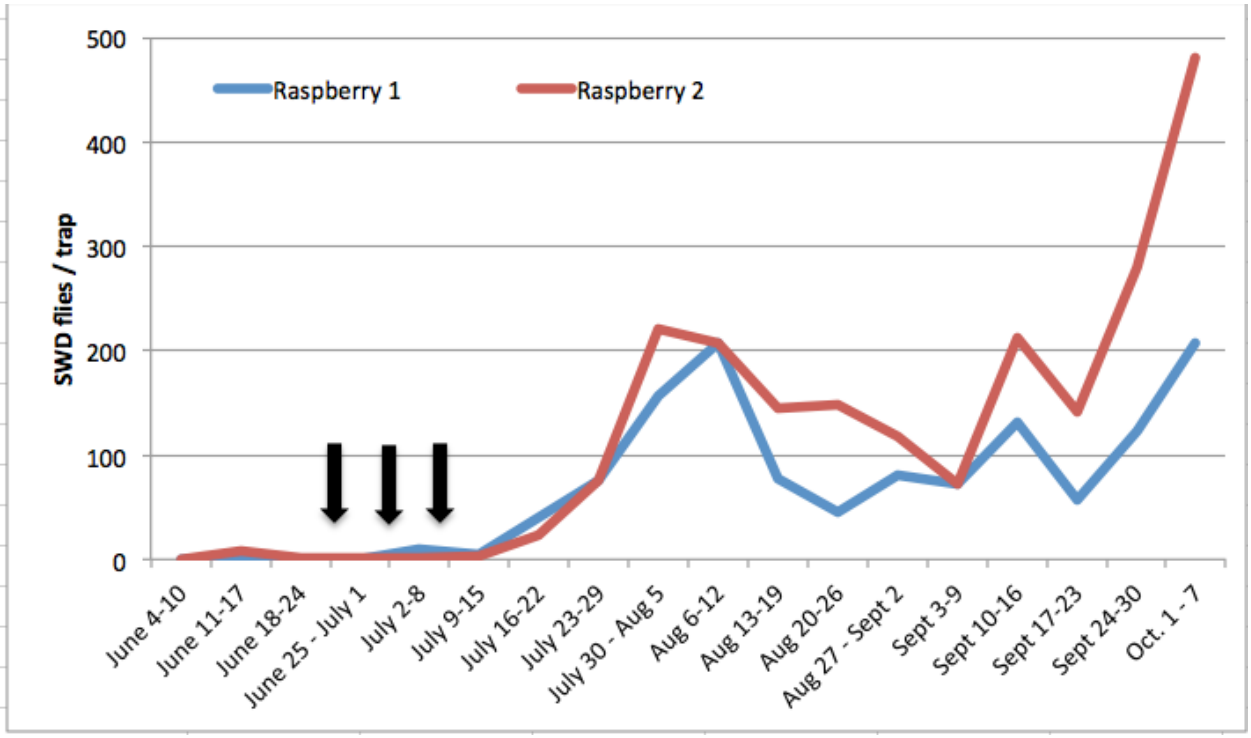

Figure 6. Adult SWD population trends in **Clark** County in **raspberry** using Scentry trap and lure. Black arrows indicate application of Mustang Maxx. Salt water tests on the fruit were conducted on 21 Jun and 5 Jul but revealed no larvae.

Clinton County: A June-bearing strawberry field was monitored for SWD adults using Scentry traps and lures from early June through final harvest in mid-July. Populations of SWD adults were low through June but climbed to ca. 250 flies per trap by mid-July (**Figure 7**). No insecticides were applied to this field during the season, and no salt water tests were conducted on the strawberries. The nearby raspberry field was monitored weekly for the entire season, with first SWD detection the week of 4 June. No insecticides were applied to this field and harvest was over by mid-July. Fly populations fluctuated between 50-300 flies per trap for most of the season, and actually trended lower as the season progressed, possibly as a result of reduced fruit availability (**Figure 7**). Only one salt water test was conducted on 21 June, which revealed no larvae found in 50 raspberry fruit.

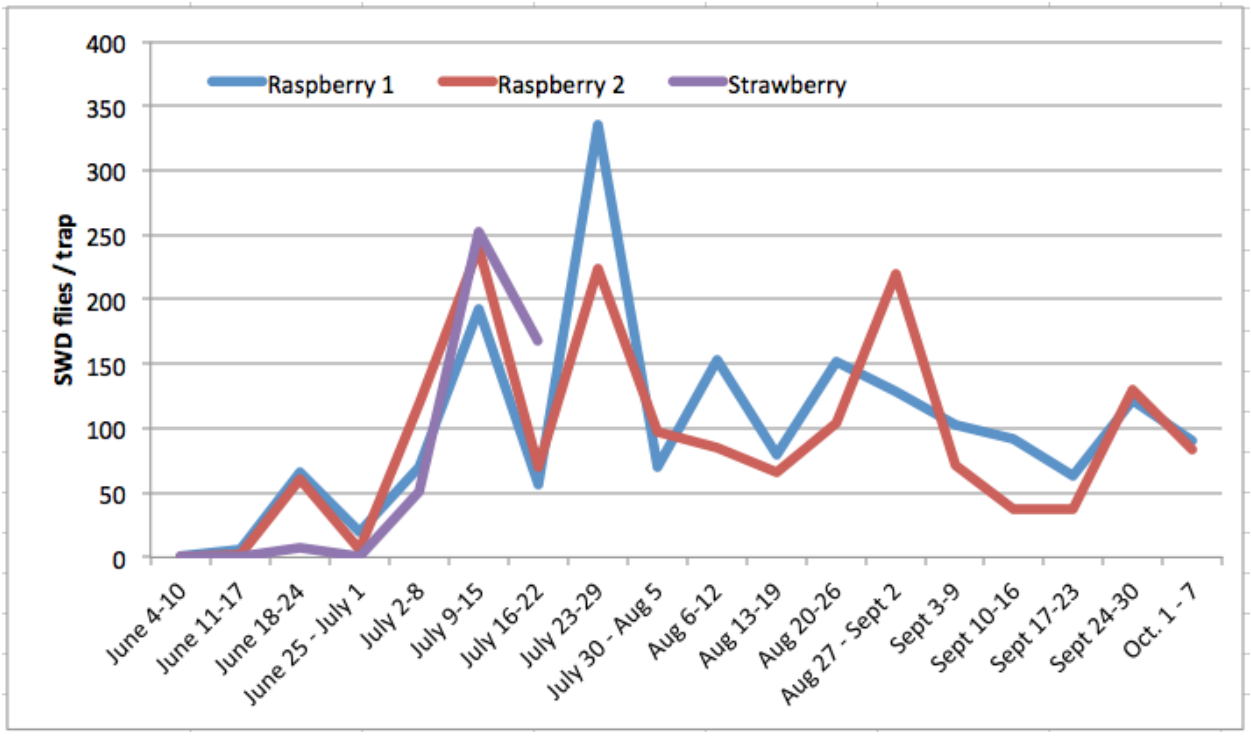

Figure 7. Adult SWD population trends in **Clinton** County in **raspberry** using Scentry trap and lure. One salt water test was conducted on 21 June revealing no larvae.

Warren County: A vineyard was monitored for adult SWD using Scentry traps and lures from June through September. Insecticide applications of Danitol (fenpropathrin) as shown by orange arrows, and Baythroid (cyfluthrin) as shown by blue arrows, were made nearly every two weeks from 4 June through 15 September (**Figure 8**). Trap catches remained under 40 flies for the entire season. Salt water tests on grapes collected 26 July revealed 0 larvae, on 30 August revealed 7 larvae, and on 9 September revealed 4 larvae per large bunch of grapes. Given the condition of the grapes with some cracks and rots in the bunch, it is difficult to say for certain if these floated larvae were SWD or another species of Drosophilid.

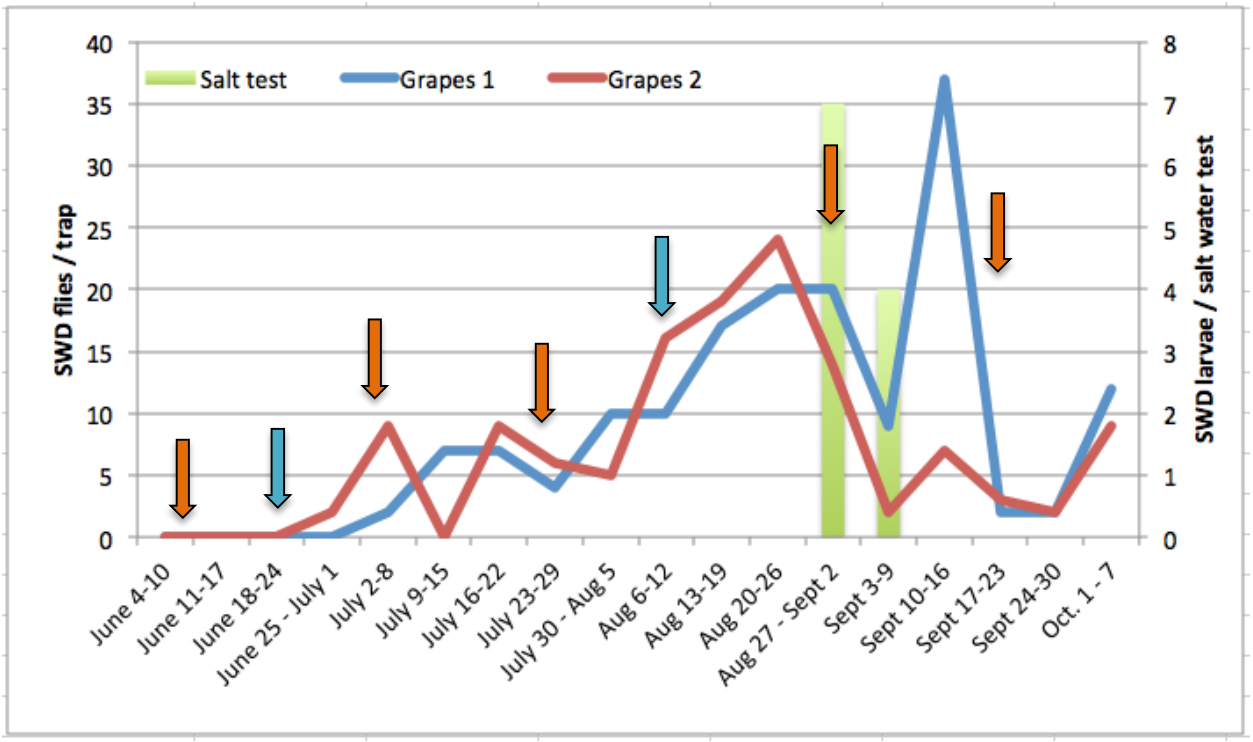

Figure 8. Adult SWD population trends in **Warren** County in **grape** using Scentry trap and lure. Blue arrows indicate Baythroid applications, orange arrows indicate Danitol applications. Salt water tests are indicated by the green bars.

Franklin County: Traps at this site were placed in a small raspberry field and along two wooded areas on the Waterman Farm on OSU's main Columbus campus from January through September. SWD flies were detected in the raspberry field as early as January, and in the wooded area as early as June (**Figure 9**). SWD fly populations remained below 20 flies per trap through early July, and then rose to nearly 800 flies per trap in one of the wooded locations. The highest population around the raspberry field topped out at 144 flies per trap. At this location, all traps placed near the woods had higher peak catches of SWD flies than traps placed near raspberries. No insecticides were applied directly to these areas and no salt water tests were conducted on the raspberry fruit.

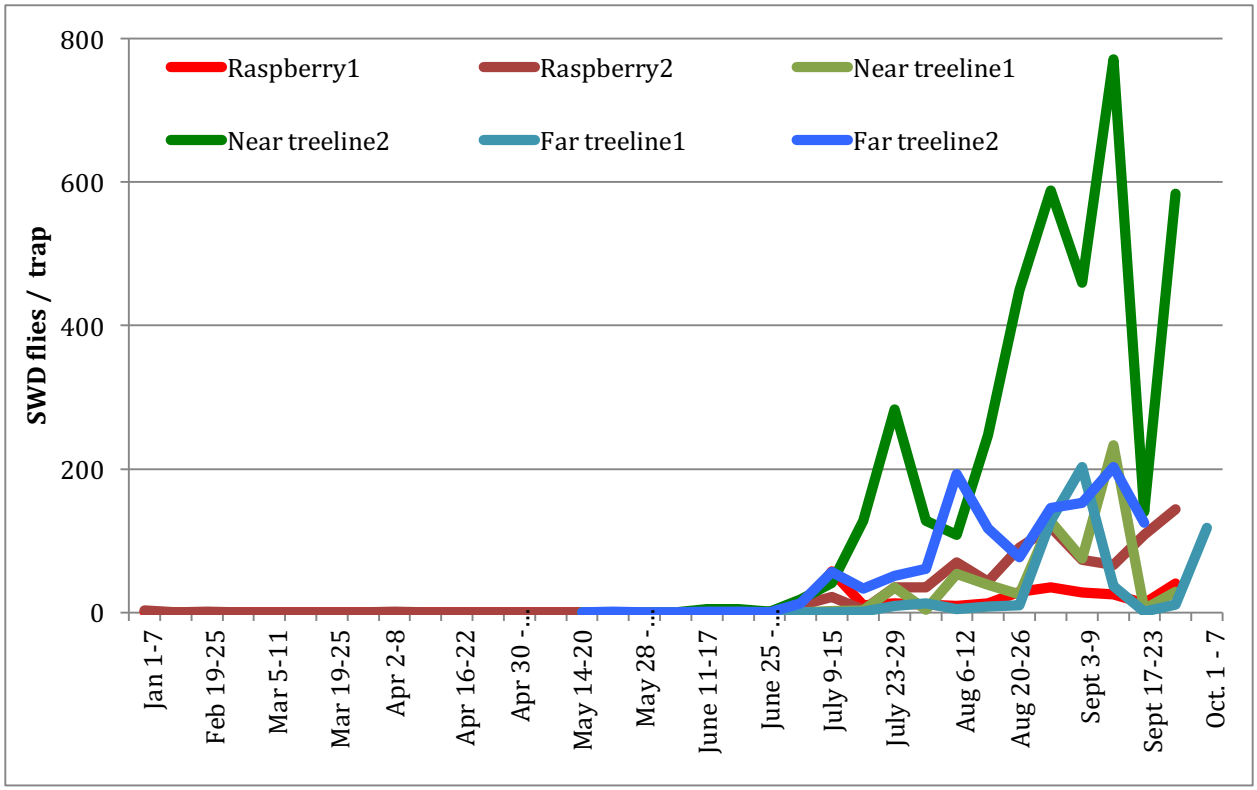

Figure 9. Adult SWD population trends in **Franklin** County in **raspberry and surrounding woods** using Scentry trap and lure. No insecticides were applied to the crop at this location and no salt water tests were conducted at this site.

Summary for SWD monitoring: As in previous years of conducting this survey, adult SWD flies were captured in nearly all locations where a trap was placed near a cultivated host crop, alternative host crop, or wooded area. By placing traps out earlier in the year along the edge of wooded areas adjacent to cultivated crops, it was demonstrated that SWD flies are present and active much earlier than previously known. While there are many products and active ingredients registered for SWD adult control, differences in efficacy can be seen in the number of adults trapped after various treatment regimes. Under moderate to high pressure, products like Entrust and Evergreen do not perform as well as some of the pyrethroids.

Most of the sites monitored in 2017 had at least a few salt water tests to judge the efficacy of the spray program, which is helpful in determining if adjustments to products or timing is needed. Despite some sites having high fly activity based on trap catches, ultimately larval infested fruit is a better measure of SWD infestation and will determine the quality and yield for that site.

Part 2: Brown marmorated stink bug (BMSB).

A clear double-sided sticky panel on a 5-foot wood stake (**Figure 10**) was used as a new type of trap to monitor stink bugs in 2017. Traps were made by Trécé Inc. Lures, also made by Trécé, were changed every 12 weeks. Three traps were set up at each of 25 sites in 20 counties, and serviced by 14 Extension Educators, 2 research farm managers, and 2 university technicians. A change in 2017 was that traps at most sites were set up along a treeline adjacent to a crop field rather than being placed at the edge of a crop field. Adjacent crop fields included sweet corn, mixed vegetables, raspberries, grapes, peaches, apples, and soybeans. Most traps were set up in mid-May. Traps were in place for an average of 19 weeks (range, 8 to 31 weeks). As detailed below (**Table 2**), the highest density of BMSB was caught in Butler, Wayne, Greene, Franklin, and Warren Counties. Compared to the previous few years, BMSB was found more consistently in more counties in 2017 (**Figure 11**), although at density quite low (< 0.4 bug per trap per week) at 7 sites. One site (Champaign County) had its first positive catch in 2017. Two sites (Morgan Co., Wayne Co.) that had zero catch in 2016 did catch BMSB in 2017 although they had had positive reports in years before 2016. We now have confirmed reports of BMSB detection in 50 of Ohio's 88 counties. Next year we would like to expand BMSB monitoring into counties where we have not yet had reports received or traps deployed.

Figure 10. Sticky panel trap used to monitor stink bugs.

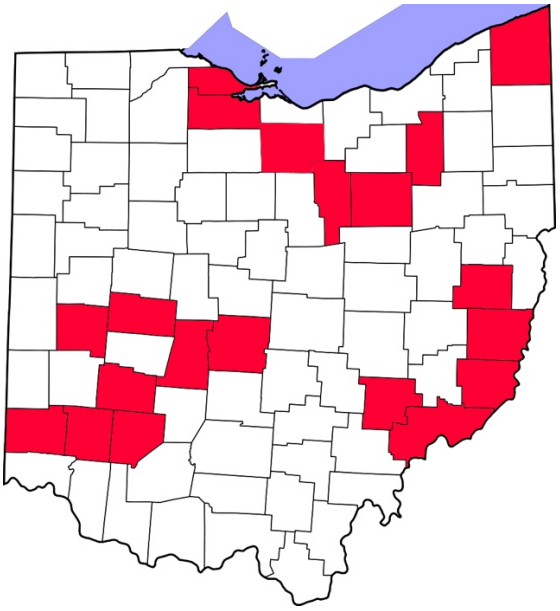

Figure 11. BMSB distribution as reported by the 2017 monitoring network; red indicates traps in that county detected BMSB.

Table 2. Summary of brown marmorated stink bugs in pheromone traps at Ohio sites, 2017.

County	Cooperator	Total # BMSB	# traps	# weeks	Mean # BMSB per trap per week
Butler	C. Meyer	179	3	12	4.97
Wayne-2	K.Tilmon/A.Raudenbush	247	3	22	3.74
Greene	J. Jasinski	614	6	28	3.65
Franklin-3	C. Welty	117	2	21	2.79
Franklin-4	C. Welty	124	3	15	2.76
Warren	J. Jasinski	166	3	24	2.31
Franklin-1	C. Welty	409	6	31	2.20
Summit	J. Kowalski	91	3	16	1.90
Franklin-2	C. Welty	113	3	24	1.57
Huron	B. Filbrun/E. Long	108	3	23	1.57
Clinton	J. Jasinski	246	6	27	1.52
Washington	M. McCartney	47	3	12	1.31
Ashtabula	E. Long/A. Kirk	67	3	24	0.93
Wayne-1	R. Lewandowski	43	3	18	0.80
Champaign	A. Douridas	44	3	20	0.73
Madison	M. Griffith	11	3	8	0.46
Lorain	T. Malinich	27	3	20	0.45
Harrison	E. Lyon	14	3	14	0.33
Monroe	M. Landefeld	13	3	22	0.20
Miami	A. Bennett	4	3	9	0.15
Morgan	C. Penrose	5	3	12	0.14
Ashland	T. Malinich	7	3	21	0.11
Sandusky	A. Gahler	6	3	21	0.10
Ottawa	A. Gahler	3	3	21	0.05
Belmont	D. Lima	1	3	9	0.04

Part 3: Swede midge.

This new invasive pest of cole crops was monitored by sticky cardboard 'Jackson' pheromone traps set in the crop canopy (**Figure 12**). Three traps per field were set up on 16 May in two commercial cabbage fields and one research cabbage field in Sandusky County. Sticky panels were replaced everyone to two weeks until early August by an Extension Educator and his summer intern. Lures were replaced every four weeks. After cabbage was harvested, two traps were moved to a diversified vegetable farm in Ottawa County, and monitored during September. An additional trap was set up in one planting of collards in Franklin County in mid-June and monitored until late October. All trap panels were examined under high magnification by a technician at OSU. In nearly every trap, every week, there were several insects that were quite similar to the swede midge, but none was determined to be positive for this species. In the future, monitoring for this pest might be more worthwhile in Brassica greens rather than in cabbage because greens are more susceptible to attack by this pest. Effort should be made to position the traps higher in the canopy and over mulch so that less soil would be blown into sticky panels.

Figure 12. Sticky trap for swede midge.